
DIVERSITY OF THE FLORA OF FAN SI PAN, THE HIGHEST MOUNTAIN IN VIETNAM¹

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ABSTRACT

Fan si Pan, situated in northern Vietnam near the border with China and reaching an altitude of 3143 m, is the highest mountain in Vietnam. The flora of this mountain and surrounding region is rich, containing a mixture of subtropical and temperate components. It also supports many relictual plant species that possibly represent remnant extensions of the old, subtropical flora of the southern Yunnan Province of China. The flora is diverse and characterized by the following: Aceraceae (*Acer*); Cupressaceae (*Fokienia hodginsii* (Dumm) Henry & Thomas); Ericaceae (*Rhododendron*, *Vaccinium*); Fagaceae (*Castanea*, *Castanopsis*, *Fagus*, *Lithocarpus*, *Quercus*); Juglandaceae (*Carya*, *Engelhardtia*, *Juglans*, *Platycarya*); Lauraceae (*Beilschmiedia*, *Machilus*, *Phoebe*, *Neolitsea*); Magnoliaceae (*Liriodendron*, *Magnolia*, *Manglietia*, *Michelia*); and Pinaceae (*Abies nukiangensis* Cheng & L. K. Fu, *Tsuga chinensis* (Franch.) Pritz).

Fan si Pan, located at 22°09'–23°30'S, 103°–103°59'E and reaching an altitude of 3143 m, is the highest point in Vietnam. It is situated in the mountainous northwest province of Lào Cai. Fan si Pan and its contiguous mountain range are oriented along the Red River in roughly a northwest to southeast direction and extend into the Yunnan Province of China and to the Himalayan chain to the northwest. This range of mountains is derived from rocks of gneiss and ancient granite. The climate is humid or perhumid (76–96%) year-round with an average yearly rainfall of 2770 mm; the heaviest rains are concentrated in the months of July and August. The average temperature is about 15°C, with a range between –3°C and 20°C. December and January are the coldest months, when snow can fall for 1–3 days each year.

This paper presents a listing of plant species from this diverse region of Vietnam, discusses the main vegetation types occurring there, and relates the Sino-Himalayan affinities of specific taxa to past climatic shifts believed to have occurred in this region.

FLORISTIC DIVERSITY

On the basis of published works by Lecomte (1907–1951), Vo Van Chi (1975), Aubreville et al.

(1960–1983), Ke et al. (1969–1976), Ho (1970–1972, 1991–1993) and Loc (1984), and results from our preliminary investigations (1991–1992), the flora of Fan si Pan is reported and arranged according to the Brummitt (1992) system, including 1750 species belonging to 680 genera in 210 families of 7 divisions as presented in Table 1.

Table 2 shows that in only 22 families, 746 species, or 43% of the total species found on Fan si Pan, are represented. There are several widespread and well-known families with abundant taxa represented in the flora. The most significant of these include the Orchidaceae (26 genera and 62 species), Asteraceae (36 genera and 59 species), Ericaceae (6 genera and 58 species), Poaceae (30 genera and 47 species), and Cyperaceae (6 genera and 42 species).

In the Fan si Pan flora there are also many species-rich genera with a large number of taxa. These genera are listed in Table 3.

Table 3 shows that in only 26 genera, representing 3.8% of the 680 known genera in the region, the 388 species comprise nearly 22% of the total in the flora, suggesting that the region around Fan si Pan and the local conditions have selectively encouraged diversification in several genera.

A diversity of morphologies are found in the flora

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Table 1. Diversity of plant divisions represented in the flora of Fan si Pan.

Division	Species	Genera	Families
Bryophyta	180	40	25
Psilotophyta	1	1	1
Lycopodiophyta	20	2	2
Equisetophyta	2	1	1
Polypodiophyta	300	86	27
Gymnospermae	10	8	6
Angiospermae	1237	542	148
Dicotyledons	1022	443	131
Monocotyledons	215	99	17
Totals	1750	680	210

as well. Widespread forest genera with large trunks are found, such as *Beilschmiedia*, *Phoebe*, *Machilus* (Lauraceae); *Eberhardtia* (Sapotaceae); *Castanopsis*, *Lithocarpus* (Fagaceae); *Schima* (Theaceae); *Altingia* (Hamamelidaceae); and *Fokienia* (Cupressaceae). Different from typical tropical trees from hot, humid forest conditions, species of these woody plants from Fan si Pan lack buttresses. Woody lianas are for the most part absent from the flora, yet vines are common.

Besides mosses, which are very common, the most common epiphytes found in the Fan si Pan

Table 2. Most species-rich families in the flora of Fan si Pan ranked by species.

Family	Genera	Species
Rosaceae	12	80
Orchidaceae	26	62
Asteraceae	36	59
Ericaceae	6	58
Poaceae	30	47
Cyperaceae	6	42
Lamiaceae	23	42
Rubiaceae	12	38
Urticaceae	10	37
Fagaceae	5	33
Moraceae	4	28
Theaceae	10	27
Gesneriaceae	11	23
Myrsinaceae	4	23
Fabaceae	10	21
Lauraceae	8	21
Acanthaceae	9	20
Commelinaceae	10	20
Aceraceae	1	19
Symplocaceae	1	16
Magnoliaceae	4	15
Melastomataceae	10	15
Totals	248	746

Table 3. Most speciose genera in the flora of Fan si Pan ranked by total number of species.

Genus	Family	Number of species
<i>Rhododendron</i>	Ericaceae	40
<i>Rubus</i>	Rosaeae	36
<i>Carex</i>	Cyperaceae	36
<i>Ficus</i>	Moraceae	23
<i>Acer</i>	Aceraceae	19
<i>Symplocos</i>	Symplocaceae	16
<i>Asplenium</i>	Aspleniaceae	15
<i>Diplazium</i>	Woodiaceae	15
<i>Lithocarpus</i>	Fagaceae	13
<i>Liparis</i>	Orchidaceae	12
<i>Vaccinium</i>	Ericaceae	12
<i>Viola</i>	Violaceae	12
<i>Castanopsis</i>	Fagaceae	11
<i>Eurya</i>	Theaceae	11
<i>Pilea</i>	Piperaceae	11
<i>Ardisia</i>	Myrsinaceae	10
<i>Begonia</i>	Begoniaceae	10
<i>Dryopteris</i>	Dryopteridaceae	10
<i>Lepisorus</i>	Polypodiaceae	10
<i>Meliosma</i>	Sabiaceae	10
<i>Polygonum</i>	Polygonaceae	10
<i>Pteris</i>	Adiantaceae	10
<i>Michelia</i>	Magnoliaceae	9
<i>Clematis</i>	Ranunculaceae	9
<i>Quercus</i>	Fagaceae	9
<i>Tetrastigma</i>	Vitaceae	9
Total		388

flora are in the following families: Acanthaceae: *Staurogyne petelotii* R. Ben.; Ericaceae: including *Rhododendron poilanei* Dop, *Vaccinium poilanei* Dop; Gesneriaceae: *Lysionotus petelotii* Pell., *Lysionotus* spp., and *Aeschinanthus*; Loranthaceae: *Loranthus parasiticus* Druce; Orchidaceae: *Liparis* spp., *Dendrobium* spp., and *Aerides* spp. Distinctive from other typically tropical and subtropical floras are epiphytic species in the Ericaceae, Acanthaceae, and Gesneriaceae.

The herbaceous plant composition varies with microclimatic conditions, and thus with habitat. Along streams or in moist valleys under the cool, shaded forest canopy there are several species of Acanthaceae, Aristolochiaceae, Begoniaceae, Gesneriaceae, Myrsinaceae, Piperaceae, and Urticaceae. Under the dense forest canopy in deep shade the few plants that can survive are those that do not depend on light for growth but, rather, obtain nutrients from decaying plant matter, such as the saprophytic *Balanophora pierrei* Van Tiegh. It is worth noting here that taxa of Aristolochiaceae, Begoniaceae, Gesneriaceae, and Urticaceae are very

common in the flora of Fan si Pan, while some families that could be expected here because they are common in many other tropical forests are mostly absent, such as taxa in the Araceae and Euphorbiaceae.

A great number of species occur at Fan si Pan that have attractive flowers and leaves or interesting leaf shapes, particularly species of Ericaceae: *Rhododendron* (40 species), with various-colored flowers; Aceraceae: *Acer* (19 species); Hippocastanaceae: *Aesculus wangii* Hu; Rosaceae: *Sorbus*, with leaves becoming red in winter; Trilliaceae: *Paris* (3 species), with attractive flowers and leaves. Many of these species could be valuable to horticulture as subtropical and temperate ornamentals.

DIVERSITY OF FLORISTIC COMPONENTS

The flora of Fan si Pan is also interesting for its apparently high endemism. Preliminary estimates from the available information accumulated for this study indicate that up to 30% endemism occurs in the flora. For example, the Orchidaceae have 19 endemic species reported for northern Vietnam; 18 of them can be found at Fan si Pan. The genus *Carex* of the Cyperaceae has 7 species endemic to northern Vietnam; 6 of these have been collected at Fan si Pan. According to Vo Van Chi (1975), 25 genera and 39 species were discovered and initially described from collection records from Fan si Pan.

The Fan si Pan flora supports tropical, subtropical, and temperate elements.

TROPICAL ELEMENT

Most of the tropical elements in the Fan si Pan flora are distributed well below an altitude of 1500 m, yet some extend as high as 2000 m. These taxa are members of the Annonaceae, Araceae, Clusiaceae, Combretaceae, Cyatheaceae, woody Euphorbiaceae, Gnetaceae, Hernandiaceae, Icacinaceae, Polygonaceae, and Proteaceae. Such tropical genera and species as *Actinodaphne*, *Aleurites*, *Artocarpus*, *Calamus*, *Caryota*, *Citrus*, *Duabanga*, and *Wendlandia* are relatively common elements of the flora and constitute a significant component of the forest. This is true not only of the forest trees but also of the tropical understory shrubs and herbs that are common, such as species of *Acorus*, *Anotis*, *Balanophora*, *Calamus*, *Dichroa*, *Dioscorea*, *Diospyros*, *Disporum*, *Macaranga*, *Mallotus*, *Pasania*, *Sarcandra*, *Vernicia*, and *Wendlandia*.

SUBTROPICAL ELEMENT

The subtropical component of the flora of Fan si Pan possibly represents a Tertiary floristic element

from North Vietnam–South China suggested by the following families: Aceraceae (*Acer* with 19 spp.), Cyperaceae (*Carex* with 36 spp.), Fagaceae, Gesneriaceae, Hamamelidaceae, Lauraceae, Magnoliaceae, Myrsinaceae, Symplocaceae (*Symplocos* with 16 spp.), Theaceae, and Urticaceae. Most of the subtropical species found at Fan si Pan are located near 1600 m elevation, which is characterized by an average temperature of 15.7°C and nearly 2732–2778 mm of precipitation per year. Characteristics of the elevation, climate, and geomorphology of this region combine to maintain this subtropical element of the flora.

Subtropical taxa are represented by the following genera and species: *Hydrangea* (Hydrangeaceae); *Embelia* (Myrsinaceae); *Polygonum capitatum* F. Ham. ex D. Don, *P. flaccidum* (Meissn.) Steud., *P. palmatum* Dunn, *P. thunbergii* Sieb. & Zucc. (Polygonaceae); *Anemone* (Ranunculaceae); *Huodendron*, *Rehderodendron* (Styracaceae); *Crawfurdia*, *Gentiana* (Gentianaceae); *Schisandra*, *Kadsura* (Schisandraceae); *Buddleja*, *Fagraea* (Loganiaceae); *Cornus* (Cornaceae); *Allomorpha*, *Anerincleistus*, *Bredia*, *Fordiophyton*, *Oxyspora*, *Plagiopetalum*, *Sarcopyramis* (Melastomataceae); *Viola* (Violaceae); *Adinandra*, *Anneslea*, *Gordonia*, *Pyrenaria* (Theaceae); *Exbucklandia*, *Rhodoleia* (Hamamelidaceae); *Liriodendron*, *Manglietia*, *Magnolia* (Magnoliaceae); and *Sorbus*, *Potentilla* (Rosaceae).

TEMPERATE ELEMENT

At altitudes above 2000 m, the Fan si Pan flora contains temperate floristic elements characterized by *Paris* (Trilliaceae); *Alnus*, *Betula* (Betulaceae); *Enkyanthus*, *Leucothoea*, *Pieris*, *Rhododendron*, *Vaccinium* (Ericaceae); *Celtis*, *Ulmus* (Ulmaceae); *Castanea*, *Fagus*, deciduous *Quercus* (Fagaceae); *Aesculus* (Hippocastanaceae); *Juglans*, *Platycarya* (Juglandaceae); *Crawfurdia*, *Gentiana* (Gentianaceae); *Abies*, *Tsuga* (Gymnospermae); *Huperzia* spp. (Lycopodiophyta); *Coptis*, *Ranunculus* (Ranunculaceae); *Panax* (Araliaceae); *Hypericum* (Clusiaceae); *Salix* (Salicaceae). These genera are speciose, and many are quite frequent and widespread in this region, including, in particular, *Rhododendron* with 40 species, *Vaccinium* with 12, and *Quercus* with 9.

DIVERSITY OF VEGETATION TYPES

Although the diversity of vegetation types occurring at Fan si Pan is not yet fully understood, we can preliminarily report on the main types encountered. Their distributions appear to be associated with elevation.

1. TROPICAL VEGETATION BELT

The tropical vegetation belt formerly contained forest vegetation that has mostly been destroyed by shifting cultivation, overexploitation, and forest fires. It has subsequently been replaced by secondary forest along the valleys and by savanna on the slopes in areas not converted to cassava, rice, or maize cultivation.

1.1. Secondary forest type. This derived vegetation type is extensive and distributed along the many river and stream valleys. It is characterized by species of Lauraceae, Fagaceae, Meliaceae, Sapindaceae, Fabaceae (including Mimosaceae and Caesalpiniaceae), Magnoliaceae, and Burseraceae.

1.2. Savanna. The savanna vegetation type is also extensive and is derived spontaneously after cultivation is abandoned in a shifting agricultural system. It is characterized by the grasses *Miscanthus floridulus* (Labill.) Warb. ex K. Schumann & Lauterb. and *Saccharum arundinaceum* Retz., with some invasive and widespread trees; *Mallotus paniculatus* (Lam.) Muell.Arg., *Macaranga denticulata* Muell. Arg., *Trema orientalis* (L.) Blume, with *Musa* spp. in wetter places, and *Imperata cylindrica* (L.) Raeusch., *Cratoxylon polyanthum* Korth., *Rhodomyrtus tomentosa* (Aiton) Hassk., and *Melastoma candidum* D. Don in drier places.

2. SUBTROPICAL VEGETATION BELT

This subtropical zone can be delimited roughly between 1000 and 2000 m elevation. The temperature between these altitudes is extremely stable with a range between 15° and 17°C. Many of the subtropical taxa occurring in this zone have affinities with the Tertiary flora of northern Vietnam and southern China.

2.1. Dense evergreen forest. Dense evergreen forest was once widespread in this zone; however, due to extensive overexploitation and shifting cultivation, it can now be found only in isolated and inaccessible steep valleys and on steep slopes. The characteristic families of the forest trees are representatives of the Betulaceae, Fagaceae, Hamamelidaceae, Lauraceae, Magnoliaceae, Sapotaceae, and Theaceae.

2.2. Subtropical savanna. The derived subtropical savanna is a common type of vegetation found at these altitudes at present. It is secondary, arising after the destruction of subtropical forest most commonly by overexploitation or shifting cultivation. This widespread vegetation type is characterized by herbaceous species such as the grasses

Arundinella nepalensis Trin., *Imperata cylindrica*, *Microstegium* sp., and *Miscanthus floridulus*; shrub species including *Buddleja* spp., *Clematis leschenaultiana* DC., *Litsea cubeba* (Lour.) Pers., *Luculia intermedia* Hutchinson, *Osbeckia crinita* Benth., *Oxyspora paniculata* (D. Don) DC., *Polygonum chinense* L. var. *scabrum*, *P. paniculatum* Andr., *Porana racemosa* Roxb., *Rubus ellipticus* Smith, and *Viburnum cylindricum* Buch.-Ham. ex Don; and some trees, including *Acer campbellii* Hook. & Thoms. ex Hiern., *Alnus nepalensis* D. Don, *Itoa orientalis* Hemsl., *Platycarya kwangtungensis* Chun, *Sauravia nepalensis* DC., and *Wightia speciosissima* (D. Don) Merrill.

2.3. Subtropical grassland. Subtropical grassland is also derived after shifting cultivation, trampling and grazing by cow-buffaloes, and forest fire. Species of Poaceae, Cyperaceae, Fabaceae, and *Pteridium*, and including several shrubby species of *Melastoma*, *Osbeckia*, *Rubus*, and *Artemisia*, predominate.

3. TEMPERATE VEGETATION BELT

Temperate vegetation is found at altitudes over 2000 m and supports temperate species indicated by species in such genera as *Abies*, *Acer*, *Adinandra*, *Aesculus*, *Agapetes*, *Alnus*, *Altingia*, *Coptis*, *Cornus*, *Crawfordia*, *Embelia*, *Enkyanthus*, *Fagus*, *Fokienia*, *Hydrangea*, *Huodendron*, *Liriodendron*, *Magnolia*, *Oxyspora*, *Primula*, *Quercus*, *Rehderodendron*, *Rhododendron*, *Rhoiptelea*, *Sorbus*, *Ternstroemia*, *Vaccinium*, and *Valeriana*, among others.

3.1. Temperate forest. Temperate forest vegetation composed of the above-mentioned genera is found in the deep valleys and on steep slopes of Fan si Pan. In general, this vegetation is relatively widespread at high altitudes, where it is dominated by species in the Aceraceae, Hippocastanaceae, Fagaceae, Magnoliaceae, Lauraceae, Cupressaceae, Podocarpaceae, Pinaceae, and Taxaceae.

3.2. Montane cold savanna. This very localized vegetation type occurs on the slopes of the highest summits of Fan si Pan, which are believed to have been originally covered by forest. Again, conversion of the original forest to its present vegetation type was a result of human cultivation and burning of these areas. The montane, cold savanna supports many species of shrubs and herbaceous species belonging to the Poaceae, Cyperaceae, Liliaceae, Hypoxidaceae, Zingiberaceae, Gentianaceae, Ericaceae, Rosaceae, Melastomataceae, Lamiaceae, Hypericaceae, Gesneriaceae, and Pteridophyta.

These species are light-loving and cold-enduring, with *Arundinaria* spp. as dominant.

ARCHAIC CHARACTER OF THE FAN SI PAN FLORA

Fan si Pan contains an archaic element in the flora represented by the number of monotypic families or endemic genera that are present in the region. Families such as Bretschneideraceae, Pentaphragmaceae, Rhoipteleaceae, and Sargentodoxaceae are present at Fan si Pan. The high level of endemism, particularly for the genera and species in the Orchidaceae, and diversity in the genus *Carex*, also support the contention that this region represents a refugium for these limited distribution taxa.

Many relictual species in the genera *Exbucklandia*, *Fokienia*, *Rhodoleia*, *Rhoiptelea*, and *Sargentodoxa* (Wu Cheng Yi, 1965) occur in this region. These genera represent extensions of floristic elements from a more northern flora, particularly the subtropical flora of southern China and adjacent areas, and suggest that the more tropical climate existed across this area in the past. Fan si Pan appears to have served as a protected area for many of these taxa during glacial extensions across this region. Because of the high diversity in the flora, this has long been recognized as a center for angiosperm radiation (Takhtajan, 1969). The interaction of climate, geomorphological features (includ-

ing soil), and geology has supported an enrichment of the flora. Archaic characters of the geological structure of Vietnam support the presence of primitive vegetation and a high number of relictual species, which have occurred there for a long time and still survive today (Thai Van Trung, 1978).

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